

+ REDUCING THE NEED FOR LABOR BY MECHANIZATION
AND BETTER WORK METHODS

by
J. L. Paschal^{1/}

The demand for and the scarcity of farm labor during the past 5 years have brought about some interesting and important changes in the way farmers get work done. Some of these are undoubtedly temporary labor-saving measures, while others appear to be of a permanent nature. In some instances, developments now taking place will probably be of far-reaching importance in the future. It is not my intention to predict the future need for farm labor, especially in quantitative terms, but rather to call attention to a few changes which have taken and are now taking place. Conditions in the future, and particularly the costs of getting a job done by different methods, will vary from time to time and cause important changes in relationships. Cost in this sense includes not only the direct expenditure for labor or equipment but extends also to managerial problems.

Because of the great need for farm labor, agricultural colleges and farmers all over the nation have been searching for means of reducing the amount of farm labor needed to do a given job.

Studies made at Purdue University have shown that by the proper arrangement of farrowing pens and by locating the feed supply close to the pens, the time required for farrowing and caring for pigs can be greatly reduced. Major savings were also made by using improved methods of supplying drinking water to hogs. Running water piped to the hog lot was of course the most efficient method. Where this was not feasible the use of a tank wagon or sled to transport water eliminated a great deal of walking and carrying water in buckets. A very simple item of using a large outlet from the tank greatly reduced the time necessary to empty it.

Carter in Vermont analyzed dairy barn chores on a farm on which labor efficiency was much above average and reduced the time required to care for 22 cows by 2 hours per day.^{2/} This was done largely through the planning of dairy chores, the adoption of quick milking methods, and the expenditure of a few dollars for remodeling and for extra tools. In some of our western states where winters are not so severe, I believe the time required to care for 20 cows can be reduced considerably below that required by methods used on Carter's Vermont farm. Quick milking, milking parlors, gravity grain supply, and loafing sheds were adaptable, all help to reduce man hours.

^{1/}Presented by J. L. Paschal, Associate Economist, Colorado A and M College, Fort Collins, Colorado, at the Regional Farm Labor Conference of the Cooperative Extension Service and Labor Branch, PMA, U. S. Department of Agriculture, January 16, 1947, at Salt Lake City, Utah.

^{2/}Carter, R. M., "Labor Saving Through Farm Job Analyses," Bul. 503, Vt. Agri. Exp. Sta., June 1943.

New developments in caring for poultry promise to greatly reduce the man hours required per thousand birds. On one farm in New York only 21 minutes per thousand layers was required to do all daily chores.^{3/} All layers were housed in one building several stories high. The use of gravity in supplying feed to chickens and the use of dropping pits, deep litter, and automatic disc watering devices have enabled poultrymen to greatly increase the number of hens which one man can care for adequately. As new dairy barns and poultry houses are constructed so that more efficient use of labor is possible, the operator using obsolete methods and equipment will find himself more and more at a competitive disadvantage.

During the prewar years, farm labor, especially hand laborers, received far less training and supervision than factory workers. If a greater output was desired the usual remedy was to hire more workers. As the labor shortage became more and more acute during the progress of the war, it became increasingly evident that improvement was needed in the efficiency of hand workers, particularly those with little experience. The farm work simplification laboratory at Colorado A and M College, in cooperation with the labor section of the Extension Service, conducted several investigations and developed a number of circulars and movie films for use in training workers.

Dr. R. W. Roskelley of the Colorado Extension Service designed a check sheet to assist string bean pickers in locating their weak points. In cooperation with employees concerned with the supervision of labor, a number of Mexican Nationals were checked for efficiency in methods of picking. These workers were then interviewed and their weaknesses pointed out, and they were shown how to pick more efficiently by making every move count. After a week of picking the same workers were checked again. Their daily output had increased from 15 to 20 percent. It was also found that a good field supervisor was especially helpful in correcting the faulty methods of workers and in helping them to develop the habit of using the best methods.

The job of topping onions is a time-consuming job in Colorado. Investigations, including micromotion analyses of various methods and observations of field operations, revealed that experienced workers could, in many cases, increase their output by 15 to 20 percent.^{4/} Results from limited investigations indicate that the average worker is likely to waste more hand motion when using a topping knife than when using sheep shears. The main reason for this is that many workers cut with a pulling motion which carries the hands towards the body and away from the work center.

Observation of several groups of toppers indicated that many workers, especially women and children, failed to sharpen their cutting tools often enough. The workers who had reputations for high output were observed to sharpen their tools quite frequently.

^{3/}Hurd, L. M. and Bierly Ivan, "Saving Steps and Time in Caring for Hens," Poultry Science, January 1947, Vol. XXVI, No. 1.

^{4/}Paschal, J. L., and Roskelley, R. W., "How to Top More Onions," Press Bul. 100, Colo. Agr. Exp. Sta., September 1945.

It was found that even experienced onion toppers were inclined to become careless of their methods, especially in the late morning and late afternoon as they became tired. Stop watch studies revealed an increased output of approximately 16 percent when the worker was careful to keep his basket close to the pile row and to observe the principles of motion economy. Need of supervision to encourage workers to form and continue good work habits was demonstrated when workers were rechecked and found to have slipped back to their old inefficient habits.

Because of the shortage of personnel in Colorado but little time was devoted to actual training of workers by careful individual supervision. The field of labor saving in agriculture has barely been scratched and a great deal remains to be done if our farm workers are to receive the full benefits that may be obtained from an adequate work simplification research program combined with proper facilities for training and supervising workers.

Potato cutting is the labor bottleneck at planting time on Colorado farms. Because of the large volume of potatoes which must be cut, the old method of grasping the potato in one hand and cutting it with a pocket knife was discarded long ago on most farms. Many of the more progressive growers have adopted the use of the rotary potato cutter developed at Colorado A and M College.^{5/} It is very effective in reducing cutting labor requirements and in preventing the transmission of ring rot, but its development was based on the need for disease control rather than labor saving. From the standpoint of profits on the potato enterprise, the rotary cutter is an excellent investment but, at the same time, it is a rather expensive piece of equipment which is used but a few days each year. Research was conducted in the farm work simplification laboratory to devise a method of cutting potatoes which would use labor still more efficiently and at the same time provide satisfactory control of ring rot spread and, if possible, secure it with a lower initial cost for equipment. These results were finally obtained by the use of a double-edged knife mounted upright in a table provided with a gravity feed and a double drop disposal.^{6/} Proper use of this equipment resulted in 25 percent increased output per worker and reduced fatigue as compared to the rotary cutter. The cutting table is designed so that a constant supply of potatoes is readily available, directly opposite the worker on the far side of the knife. The worker picks up a potato and pulls it toward him, splitting it in two on the knife. The potato is then turned halfway around and pushed through the knife, and the four pieces are then dropped through a small opening as the hands reach for another potato. Since potatoes are cut both going and coming, nearly all empty travel by the hands is eliminated. This method therefore causes less fatigue than either the single-edged knife or the rotary disc.

In order to retain the essential disease-control features of the rotary cutter, a solution of mercuric chloride was run down over the double-edged

^{5/}Henderson, W. J., "The Colorado Rotary Potato Cutter," Bul. 381-A, Ext. Serv., Colorado State College, April 1944.

^{6/}Paschal, J. L., Lane, George H., and Kreutzer, W. A., "The Double-Edged Stationary Potato Cutting Knife," Bul. 493, Colo. Agri. Exp. Sta., May 1946.

blade, to reduce the spread of ring rot. Tests made by plant pathologists at Colorado A and M College have demonstrated that this method obtains essentially the same results as the rotary disc in reducing the spread of ring rot by cutting tools. In addition, the cutting table and 2-edged knife is simple and easy to construct and can be made in a few hours. Because of the low cost of the double-edged knife and table, operators having a small acreage of potatoes can also afford it. While the benefits of labor saving are important, they probably represent only a fraction of the benefits to be obtained by reducing the spread of ring rot.

The practice of picking potatoes into wire baskets is common in many areas, but it is somewhat slower than the picking belt which is widely used in Colorado. The basket requires the use of one or both hands to move it from place to place. From 1/4 to 1/2 minute for 1 or 2 persons is required to empty the basket into a sack. In many cases one picker will hold the sack open while the other empties the baskets into it. Two pictures are seldom evenly matched so the fast picker invariably waits for the slower one to finish filling his basket or slows his pace to that of the slower picker.

The use of a picking belt enables the average able-bodied male to pick about 20 percent more potatoes in a day than if he uses a basket.^{7/} This greater output does, however, require more energy through dragging the sack of potatoes. For this reason it is not much used by women and children. The sack is suspended between the knees from a belt. This leaves both hands free to scoop potatoes into the sack, and of course there is no basket to empty.

The shortage of farm labor, the difficulties connected with the use of inexperienced labor, and, to a certain extent, the indifferent attitude of some farm workers has induced farmers to look for every possible means of reducing the need for hired labor. Partially because high wages put extra money in their pockets, some potato workers in the San Luis Valley of Colorado arbitrarily decided to take 2 and sometimes 3 holidays per week during the harvest season.^{8/} This practice was particularly exasperating in the Valley, where the season is short and the danger of potatoes freezing in the ground is great. The enforced idleness of regular employees and equipment alone appears to be sufficiently important to cause farmers to exert every effort to reduce and, as far as possible, eliminate the need for day harvest hands. The unwise actions of perhaps only a few workers during periods of personal prosperity may lead to the development of methods and machines with which hand labor cannot compete in the future even at greatly reduced rates of pay.

The difficulty of securing and retaining satisfactory labor for potato picking is causing an increasing number of farmers to consider the purchase of a potato combine. A machine of this type is manufactured at Greeley, Colo., and is being used in different sections of Colorado and in several other states. Earl Cogburn of Gilcrest, Colo., who is a large grower of early potatoes, was one of the first, and is one of the most enthusiastic,

^{7/}Paschal, J. L., "How to Pick More Potatoes," Press Bul. 98, Colo. Agr. Expt. Sta., October 1944.

^{8/}Information furnished by A. J. Hamman, State Labor Supervisor for Colorado.

users of this machine. He reports that in a potato field yielding 225 sacks per acre, the machine will dig and sack on an average of 100 sacks per hour. The machine requires a relatively light tractor to pull the combine and drive the power takeoff. The machine has a remarkably light draft as demonstrated during the past summer by Mr. Cogburn who successfully used a Fordson tractor to operate it. The machine consists of a long digger chain, a short cross conveyer, and a long sorter belt running in the opposite direction of the digger chain. Under ordinary operating conditions 2 men stand at the cross conveyer and remove the vines from the potatoes. This is an important and fairly hard job which requires care to see that no potatoes remain on the vines. From 2 to 3 sorters sit or stand alongside the sorter belt and remove clods, vines, and other inert material. One man stands at the end of the sorter belt, sacks the potatoes, and sets them on to a moving truck which accompanies the machine down the field. The 2 men removing vines and the 3 sorters compose the crew which would compare with 8 to 10 able-bodied men required to hand pick the same quantity of potatoes per hour. Mr. Cogburn states that through the use of this combine he has been able to reduce his picking costs an average of 50 percent over a period of 3 years. The quality of his potatoes compares favorably with those picked by hand and he has had no difficulty because of abnormal tare. The use of this machine eliminates the need for from 6 to 8 able-bodied men. The job of removing clods and other inert material from the sorter belt is one that can easily be performed by persons of either sex 12 years of age or older. It can be done by family or other labor which is not capable of doing the heavy work of picking potatoes.

These machines have encountered some difficulty in hard land where clods are a problem, but experience and know-how have enabled operators to use this machine satisfactorily even under these conditions. In instances where clods are extremely bad, the potatoes have been picked out of the clods while the clods are allowed to go on over the belt and drop to the ground. Some farmers are considering the possibility of bulking potatoes, especially in the late potato areas where the tubers are mature and are not easily skinned or bruised at harvest time. The idea may seem rather far-fetched, but no more so than was the idea of combining potatoes 5 years ago. If potatoes may be bulked, need of the 2 men required to load the truck and the hand labor of unloading will be eliminated.

The auto and the truck have, generally speaking, largely eliminated the horse as a source of power on most farms. Furthermore, they have replaced man as a source of power for many farm jobs, or have greatly reduced the number of men required to do a given amount of farm work. For many Colorado farmers, a manure loader attached to a tractor has replaced from 4 to 10 men on such jobs as loading manure, sand, gravel, beet pulp, and other heavy bulk material. For handling manure this loader attachment replaces about 6 men. It performs as speedily at 5 p.m. as at 8 a.m. and the tractor has plenty of reserve power for handling unusually wet and heavy manure. It is always capable of moving as big a load as the fork will carry.

A loading fork mounted on a truck chassis and especially designed to remove manure from low cattle sheds was constructed by W. P. Kintzley, foreman of the Colorado A and M College farm. By replacing the manure fork with a

large fork similar to a hay sweep, this loading machine is also used to collect and transport grain bundles directly to the threshing machine, thereby eliminating the need for field pitchers and bundle trucks.

Threshing crews which used hay sweeps to collect and transport grain bundles and which handled the threshed grain in bulk were composed of about half as many men as those on which all the bundles were forked by hand and the grain moved in sacks.

A Weld County farmer uses his manure loader to remove hay from the stack when using a stationary hay grinder. For this purpose he designed a special fork with teeth made of automobile axles. Another farmer who disliked loading beet pulp with a hand fork also observed that much time was wasted by farmers waiting their turn to get into the pit. His manure loader greatly reduced the man-hours used in loading trucks at the pit and nearly eliminated the waiting line. Other farmers were glad to pay him a nominal sum to load their trucks and be on their way.

Arvid Anderson at Haxtun, Colo., used his manure loader to replace four men at corn shelling. He built a 100-bushel hopper over the sheller feeder and filled it with his manure loader. More corn was shelled per hour because of the uniform maximum flow of ear corn into the sheller.

The tractor posthold digger is rapidly increasing in popularity in sections in eastern Colorado where the soil is free from large rocks. Approximately 30 seconds are required to make a hole, as compared with several minutes of hand digging, especially in hard, dry soil.

Few people think of a tractor as replacing an irrigation shovel but that very thing is being done by more and more farmers. A study which I made in the Yellowstone Valley of Montana in 1942 revealed that improved land leveling not only saved labor but increased crop yields. Farmers reported on land which ordinarily would be considered as satisfactorily leveled but which later was leveled unusually well by modern equipment. On the average hand labor for irrigation was reduced by 50 percent and at the same time crop yields increased 20 percent, probably due at least in part to better distribution of water.

Certain methods of harvesting grain have not only reduced the total amount of man labor required but have so spread out the combining season that the entire job is done with regular hired or family labor.

A farmer living near Stoneham, Colorado, operates a large farm but has not hired a day of harvest labor during the last 5 years. As much as possible of his grain is combined in the regular manner. The remainder is windrowed with two old headers. The swaths from both headers are windrowed close enough together that later a combine with a pickup attachment picks up both windrows, or the equivalent of a 20-foot swath, at one trip around the field. This not only reduces combine travel by half but concentrates the straw which is dumped in piles by means of a buncher operated by a small boy riding the combine. Later when time and weather conditions permit, tractor buck rakes are used to buck the straw together for stacking.

Tractor power combined with timeliness helped to reduce man labor for thinning and weeding beets even before the days of segmented seed. Operations performed at the proper time before beets are planted reduce the amount of hand weeding required. This procedure is especially important when segmented seed and mechanical thinning or cross blocking are used. When whole beet seed is planted, several times as many pounds are required to seed an acre, and 20 to 30 hours of hand labor are required for blocking, thinning and weeding.^{9/} Tests made show that by the simple expedient of using 1/4 as much whole seed, hand labor was reduced about 7 hours to 21.47 hours per acre. By the use of the segmented seed and the long-handled hoe, with no hand thinning, the labor was reduced to 12.41 hours per acre. Tests made by the American Crystal Sugar Company in Minnesota and reported on by the Beet Sugar Development Foundation on 700 acres on 30 different farms in 1945 revealed some startling results.^{9/} Planting segmented seed with precision planters, cross-blocking with customary weeding tools, and weeding with a long-handled hoe reduced labor to approximately 1/4 that required by methods in common use 10 years ago. Approximately 90 percent of the beets in Minnesota were mechanically cross-blocked in 1946. The late E. M. Mervine of Colorado A and M College, did some of the pioneer work on segmented seed and mechanical cross-blocking. These two techniques eliminated hand thinning entirely and reduced man labor to 2.5 hours per acre on test plots.^{10/} The reductions of thinning labor, which I have already discussed, were obtained without significant losses in yield. There are, however, several important techniques which a farmer must observe if he is to successfully use segmented seed and mechanical thinning. The results I have given you were obtained in 1945 and earlier. The results obtained in 1946 have not generally been released yet, but from a few preliminary reports I have learned that important progress has been made in reducing labor needs. Mechanical thinning makes it possible to get the job done at the proper time. Tests made by the Montana Agricultural Experiment Station in 1946 show the importance of timeliness. All of several different methods of mechanical thinning performed at the proper time resulted in more profit than delayed hand thinning.

Tractors plus equipment are rapidly assuming man's hard labor of harvesting beets. The power beet loaders now in use on many farms enable 2 men to put on a load of beets in 5 minutes, or perhaps 10 minutes over-all time. This entirely eliminates the manual work of forking beets, representing a tremendous saving of time. The use of the loader also enables the farmer to haul many more beets per man and per truck per day.

Use of the mechanical harvester is rapidly being adopted. In 1946, 150,000 acres of beets were harvested by 2,150 mechanical harvesters.^{9/} In spite of the severe storms in some areas, this is an average of about 70 acres per machine. Expectations are that approximately 4,000 additional machines, or a total of about 6,200, will be in use in 1947. It is expected that these machines will harvest approximately 450,000 acres of beets.

^{9/}Data supplied by Phil Smith, Beet Sugar Development Foundation, Fort Collins, Colo.

^{10/}Mervine, E. M., and Barmington, R. D., "Mechanical Thinning of Sugar Beets," Bul. 476, Colo. Agr. Exp. Sta., March 1943.

The rapid adoption of this machine indicates that in spite of the fact that they are new and therefore contain many mechanical bugs, they are, in the judgment of beet raisers, proving practical.

A record of 121 machines in 1945 in Nebraska showed an average of 4.76 man hours required to place an average acre yield of 15.5 tons into the truck.^{9/} These 4.76 hours compare with 34 hours for doing the same amount of work when the beets are topped by hand. In simpler terms, the machine turns out 3 tons per man hour as compared with a little less than 1/2 ton per man hour when topping is done by hand.

A farmer living near Fort Collins purchased a new beet harvester in 1946 and, after about 1 week of learning to run the machine, he was able, with the aid of 1 man, to top and load an average of 45 tons of beets a day.^{11/} With the average quality of beet help available in 1946, he estimates that the machine and 2 men replaced 3 hand toppers in addition to labor involved in the job of lifting, and loading beets. This particular operator ran into difficulty because of an unseasonal, heavy, wet snow which kept him out of the field for a long time. However, he was thoroughly sold on the use of the mechanical topper. He believes that it will save him a great deal of money each year. Also he prefers to use the mechanical topper because of the difficulty encountered in securing labor. He was especially dissatisfied with the poor topping job done by laborers and says that the machine does a much more uniform job than do hand toppers available at the present time. Thus, mechanical harvesting of beets practically eliminates the need for seasonal labor. However, the hazard is ever present that in the event of conditions preventing the use of a harvester, the unavailability of hand labor might cause severe losses to sugar beet growers.

It is too early to accurately determine the cost of harvesting beets when the machines are completely developed, but figures available at the present time indicate that they may be half the cost of hand labor. They will undoubtedly be low enough to completely eliminate the need for hand topping in areas where mechanized equipment can be used.

Great reductions have been made in the time required to harvest corn for silage. In the days when the corn binder was used on the Colorado A and M farm, a crew of 12 men and 4 trucks for 13½ crew hours, or 160 man hours, were required to cut, chop, and place 8 acres of corn in an upright silo. An improvement which eliminated the need for 4 loaders in the field was made by building an elevator which elevated bundles of corn directly from the binder onto a truck. The introduction of a field chopper greatly reduced the man hours required to do this job. Only 3 trucks instead of 4 are required, and 7 men instead of 12, and the crew time is reduced to 10 hours. The adoption of this new equipment reduced man hours from 160 to 70 hours. An additional saving arises from the fact that the cost of twine is eliminated when field choppers are used.

^{9/}See footnote p. 7.

^{11/}Observations made by the writer.

The manufacture of combine choppers, that is, a machine that can be used for cutting and chopping corn or for picking up hay out of the windrow and chopping it, promises to greatly reduce the time of harvesting both hay and corn. A large number of these machines are now in use in the Fort Collins area. Over 100 are now on order with Fort Collins equipment dealers for delivery as soon as they are available.

Methods of harvesting hay are undergoing some very important changes. Farmers are very much interested in the number of hours of farm labor required to harvest a ton of hay. They are also concerned with the form in which the hay is harvested, particularly insofar as the method of harvesting affects the time, effort, and cost involved in feeding.

A study of methods of harvesting alfalfa hay in the irrigated sections of northern Colorado was started last June by Harry Sitler of the B.A.E. and myself representing the Colorado A and M College. The analysis of data is not complete but some very interesting facts concerning labor requirements are now available. Most of the mowing is done by tractor mowers with an average of 0.42 man hour per acre.

The job of curing hay which consisted of raking and turning operations for hay to be stacked required an average of 0.6 of an hour per ton.

The job of getting the hay from the windrow or bunch into the stack was accomplished by three different methods.

With the use of tractor buck rakes to bring hay to the stack yards and overshot tractors to raise it on to the stack, the average time required to store a ton of hay was 1.94 man hours per ton. The total harvesting time averaged 2.97 man hours per ton.

A second method, same as the first but using stripped-down autos and trucks to power the buck rakes, was only slightly faster.

A third method which is very promising so far as labor saving is concerned required only one machine - a stacker buck rake, to bring the hay to the yard and place it on the stack. The need for the overshot stacker, the truck or tractor to power it, and the driver was eliminated. Storing time was 1.26 man hours per ton compared to 1.94 man hours for the tractor buck rake method.

Some farmers speeded up the over-all crew time required to store hay by this method by using an auto or tractor buck rake to bring most of the hay in near to the stack yard where it was placed on the stack by the stacker buck rake. This equipment has the desirable feature that hay may be placed at any desired point on 3 or 4 sides of the stack. It can also be used for loading manure, bucking grain bundles for threshing and many other farm jobs.

As already mentioned a great many Colorado farmers are very much interested in field pickup choppers for harvesting alfalfa hay. These choppers not only save harvesting labor but put the hay in chopped form which growers believe is highly desirable from a feeding point of view.

Harvesting hay with a pickup chopper required the fewest man hours per ton of any method studied. This method averaged 2.2 man hours per ton compared with approximately 2.3 hours for the stacker buck which was the fastest method of putting hay in the stack. However, the stacked hay absorbs still more labor if it is to be put through a stationary chopper or grinder.

Two brothers living near Windsor have reduced to the minimum labor requirements for chopping hay from the windrow and piling it at the feedlots. Only two men make up the crew. One man operates the chopper to which is attached a rubber tired trailer to receive the chopped hay; the other man, using a pickup to pull the trailer, does the hauling and unloading which is quickly and simply done. A wire net is placed in the bottom of the trailer. Unloading is merely a matter of hooking cables on the netting to a fixed object and driving forward. The netting does the rest. When enough loads are on the ground to make it worth while a manure loader is used to pile it into the desired rick in a matter of a few minutes.

This procedure requires about 1 man hour per ton for storing in this manner as compared with 3 for putting loose hay up in the stack and later hauling it to the feed yard.

A few farmers took short cuts in storing and grinding alfalfa hay by bucking it directly to a stationary grinder instead of stacking it. Total man hours per ton were approximately the same as putting it in stack. Compared with grinding from the stack, grinding from buck rakes saved all the time required to pitch from the stack into the grinder.